

# **TREVIGEN® Instructions**

*For Research Use Only. Not For Use In Diagnostic Procedures*

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## **T4-Endo V FLARE™ Assay Kit**

**Reagent Kit for Analysis of DNA Damage in  
Single Cells Using the Trevigen CometAssay®  
and T4-Endonuclease V**

**Catalog # 4055-100-FK**

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<b>Table of Contents</b>	<b>Page</b>
<b>I. Background</b>	<b>1</b>
<b>II. Precautions and Limitations</b>	<b>1</b>
<b>III. Materials Supplied</b>	<b>2</b>
<b>IV. Materials Required But Not Supplied</b>	<b>2</b>
<b>V. Reagent Preparation</b>	<b>2</b>
<b>VI. Sample Preparation and Cell Storage</b>	<b>5</b>
<b>VII. FLARE™ Assay Protocol</b>	<b>6</b>
<b>VIII. Optimization of Assay Conditions</b>	<b>8</b>
<b>IX. Controls</b>	<b>9</b>
<b>X. Data Analysis</b>	<b>9</b>
<b>XI. Troubleshooting Guide</b>	<b>10</b>
<b>XII. References</b>	<b>11</b>
<b>XIII. Related Products Available from Trevigen</b>	<b>12</b>
<b>XIV. Appendices</b>	<b>14</b>

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## I. Background

Trevigen's **T4-Endo V FLARE™** (Fragment Length Analysis using Repair Enzymes) **Assay Kit** provides the ability to detect DNA damage in single cells using T4-endonuclease V (T4-Pyrimidine Dimer Glycosylase/T4-PDG) in conjunction with Trevigen's **CometAssay®** single cell gel electrophoresis kits. To assess the type of DNA damage induced by a putative mutagen, drug, or treatment regimen, cells are harvested after treatment and immobilized in low melting point agarose (LMAgarose) on FLARE™ Slides (Cat# 3950-075-02). The cells are gently lysed and then incubated with T4-Endo V, which recognizes *cis-syn* cyclobutane pyrimidine dimers and AP sites. T4-Endo V also cleaves AP sites on double and single-stranded DNA.

The slides are then immersed in an alkali solution, to unwind the DNA strands, and subjected to alkali gel electrophoresis. Denatured, cleaved DNA fragments migrate out of the cell under the influence of an electric field, whereas undamaged supercoiled DNA remains within the confines of the nuclear cell membrane. Evaluation of the DNA "comet" tail shape and migration pattern after staining with a fluorescent DNA intercalating dye, or silver staining, allows for assessment of the extent of DNA damage. The type of DNA damage is inferred from the substrate specificity of T4-Endo V.

Qualitative data may be generated if the comets are scored according to categories of small to large comet tail DNA content. Quantitative and statistical data can readily be generated by analysis of the results with image analysis software that calculates tail length and tail moment (see Section X: *Data Analysis*, page 9). Trevigen's exclusive FLARE™ Slide, available as a separate order or as part of the FLARE™ Assay Kits, promotes adherence of LMAgarose, eliminating the time consuming and unreliable traditional method of preparing base layers of agarose. These slides shorten assay time and permit the rapid and reliable analysis of large numbers of samples in a standard format. SYBR® Green I<sup>1</sup> is included in the kit for DNA visualization with improved sensitivity compared to ethidium bromide.

## II. Precautions and Limitations

1. For Research Use Only. Not for use in diagnostic procedures.
2. The physical, chemical, and toxicological properties of the products contained within Trevigen's **FLARE™ Assay Kits** may not have been fully investigated. Therefore, Trevigen recommends the use of gloves, lab coats, and eye protection while using any of these chemical reagents. Trevigen assumes no liability for damage resulting from handling or contact with these products.
3. Lysis Solution contains 1% sodium lauryl sarcosinate which is an irritant. In case of eye or skin contact, wash thoroughly under running water. In case of ingestion, rinse mouth with water and seek medical advice.
4. SYBR® Green I contains DMSO. Please refer to Material Safety Data Sheets.

<sup>1</sup>SYBR Green I is a registered product of Molecular Probes, Eugene OR, and is sold under license from Molecular Probes, Inc. Please see p. 14 for complete licensing terms. Use of this reagent outside the scope of these terms is not endorsed by Trevigen, Inc.

### III. Materials Supplied

#### Module 3950-075-SP

<u>Component</u>	<u>Amount Provided</u>	<u>Storage</u>	<u>Catalog #</u>
Lysis Solution	2 x 500 ml	Room temp.	4250-050-01
Comet LMAgarose	15 ml	4 °C	4250-050-02
FLARE™ Slides	25 each*	Room temp.	3950-075-02
SYBR® Green I nucleic acid gel stain	5 µl*	-20 °C	4250-050-05

#### Module 4055-100-FM

<u>Component</u>	<u>Amount Provided</u>	<u>Storage</u>	<u>Catalog #</u>
T4-Endo V	100,000 units	4 °C	4055-100-01
25X FLARE™ Buffer 1	40 ml	Room temp.	3950-040-01
REC™ Dilution Buffer	10 ml	-20 °C	3950-010-03
100X BSA Additive	100 µl	-20 °C	3950-100-04

\*Additional FLARE™ Slides (x100), cat# 3950-300-02, available from Trevigen.

### IV. Additional Materials/Equipment Required but not Supplied

#### Equipment:

- 1-20 µl, 20-200 µl, 200-1000 µl pipettors, and tips
- Serological pipettor and pipettes
- Boiling water bath and 37 °C water bath (hot plate not recommended)
- Horizontal electrophoresis apparatus
- Epifluorescence microscope equipped with Fluorescein filter
- 1 L beaker
- 4 °C refrigerator
- Humidity chamber
- Hydrophobic Coverslips<sup>1</sup> (cat# 4867-100)

#### Reagents:

- 10X PBS, Ca<sup>2+</sup> and Mg<sup>2+</sup> free<sup>1</sup> (cat# 4870-500-6)
- 10N NaOH
- Dimethylsulfoxide (optional)
- Ethanol
- 500 mM EDTA, pH 8.0
- Tris HCl, pH 7.5
- Glycerol
- p-Phenylenediamine dihydrochloride (pH 7.5-8)
- Deionized water
- NaOH pellets

<sup>1</sup>Sold separately

### V. Reagent Preparation

Reagents marked with an asterisk (\*) should be prepared immediately before use. Wear gloves, lab coat, and eye protection when handling any chemical reagents.

**1. 1X PBS Ca<sup>2+</sup> and Mg<sup>2+</sup> free (sold separately)**

Dilute 10X PBS with deionized water to prepare 1X PBS. Store at room temperature. (10X PBS is available from Trevigen, cat# 4870-500-6).

**2. Lysis Solution**

For up to 10 slides (3 samples per slide) prepare:

Lysis Solution (cat#4250-050-01)	40 ml
DMSO	4 ml (optional)

Chill at 4 °C, or on ice, for at least 20 minutes before use. The addition of DMSO is optional and is required only for samples containing heme, such as blood cells or tissue samples.

**3. Comet LMAgarose**

The Comet LMAgarose is ready to use once molten. Loosen the cap to allow for expansion then heat the bottle in a 90-100 °C water bath for 5 minutes, or until the agarose is molten (Caution: Microwaving is not recommended). Place the bottle in a 37 °C water bath for 10 minutes to cool. The LMAgarose will remain molten at 37 °C for sample preparation indefinitely.

**4. T4-Endo V Enzyme Dilutions**

The final concentration of T4-Endo V to be used in FLARE must be optimized for your particular cell line and type of exposure to maximize the difference in comet size between UV-exposed cells treated with T4-Endo V and those exposed to reaction buffer only. Typical final dilutions for T4-Endo V are 1:100, 1:500, and 1:1,000, depending upon the unit activity of the enzyme. We recommend starting with undiluted enzyme and thereafter making initial dilutions (e.g. 1:5 and 1:10) in **REC™ Dilution Buffer**, which is provided in Trevigen's **T4-Endo V FLARE™ Assay Kit**. Take 1 µl of undiluted enzyme or 1 µl of the initial dilutions and dilute 1:75 in FLARE Reaction Buffer (see step 7 below) for direct application to the FLARE Slide sample areas. The long term stability of diluted forms of T4-Endo V has not been established, therefore, immediate use of diluted enzyme is recommended.

**6. 1X FLARE™ Buffer 1**

Prepare the 1X FLARE™ Buffer 1 (sufficient for 10 slides):

25X FLARE™ Buffer 1, cat# 3950-040-01	6 ml
Deionized water	144 ml

**7. T4-Endo V FLARE™ Reaction Buffer**

Prepare the following T4-Endo V FLARE™ Reaction Buffer (sufficient for 10 samples):

25X FLARE™ Buffer 1, cat# 3950-040-01	40 µl
100X BSA Additive, cat# 3950-100-04	10 µl
Deionized water	to 1 ml

Store at 4 °C for up to 1 week, or freeze at -20 °C for long-term storage.

**8. Working T4-Endo V Enzyme Solutions**

Each sample area on the FLARE™ Slide requires 75 µl of working T4-Endo V Enzyme Solution prepared as follows (for 1 sample area):

T4-Endo V FLARE™ Reaction Buffer (prepared in Step 7)	75 µl
Diluted T4-Endo V Enzyme (prepared in Step 4)	1 µl

Place on ice and use immediately.

**9. Alkaline Electrophoresis Solution pH >13 (200 mM NaOH, 1 mM EDTA) for the CometAssay® ES system:**

Prepare a stock solution of 500 mM EDTA, pH 8.

For 1 liter of electrophoresis solution:

NaOH pellets	8 g
500 mM EDTA, pH 8	2 ml
dH <sub>2</sub> O (after NaOH is dissolved) q.s. to:	1 liter

Use of freshly made solution is recommended. Store 50 ml at room temperature and chill the remainder at 4 °C.

**OR: Alkaline Electrophoresis Solution pH >13 (300 mM NaOH, 1 mM EDTA) for other electrophoresis systems:**

Prepare a stock solution of 500 mM EDTA, pH 8.

For 1 liter of electrophoresis solution:

NaOH pellets	12 g
500 mM EDTA, pH 8	2 ml
dH <sub>2</sub> O (after NaOH is dissolved) q.s. to:	1 liter

Adjust the volume prepared based on the dimensions of your electrophoresis apparatus. Use of freshly made solution is recommended. Store 50 ml at room temperature and chill the remainder at 4 °C.

**10. SYBR® Green I Staining Solution**

Prepare SYBR® Green I Staining Solution from the SYBR® Green I nucleic acid gel stain provided (10,000X concentrate in DMSO).

SYBR® Green I nucleic acid gel stain (cat# 4250-050-05)	1 µl
TE Buffer, pH 7.5 (TE: 10 mM Tris-Cl (pH 7.5), 1 mM EDTA)	10 ml

The diluted stock is stable for several weeks when stored at 4 °C in the dark.

**11. Anti-fade Solution (optional)**

Prepare if fading of samples occurs. In a 50 ml tube, mix until dissolved:

p-Phenylenediamine dihydrochloride	500 mg
10X PBS	4.5 ml

Add approximately 400 µl of 10 N NaOH dropwise with stirring until pH of solution reaches 7.5-8.0. Make volume up to 5 ml with 10X PBS, add glycerol for a final volume of 50 ml, and vortex thoroughly. Apply 10 µl

per sample area, apply cover slip and seal with enamel nail polish. Re-staining of slides is not recommended. Store antifade solution at -20 °C for up to one month. Darkening of solution may occur.

## **VI. Sample Preparation and Cell Storage**

Cell samples should be prepared immediately before starting the assay, although success has been obtained using cryopreserved cells (see below). Cell samples should be handled under dimmed or yellow light to prevent DNA damage from ultraviolet light. Buffers should be chilled to 4 °C or on ice to inhibit endogenous damage occurring during sample preparation and to inhibit repair in the unfixed cells. PBS must be calcium and magnesium free to inhibit endonuclease activities. The appropriate controls should also be included (see below). Optimal results in the FLARE™ Assay are usually obtained with 50-150 cells per FLARE™ Slide sample area. Using 40 µl of a cell suspension at 1 x 10<sup>5</sup> cells per ml combined with 400 µl of LMAgarose will provide the correct agarose concentration and cell density for optimal results when plating 40 µl per sample.

### **Suspension Cells**

Cell suspensions are harvested by centrifugation. Resuspend cells at 1 x 10<sup>5</sup> cells/ml in ice cold 1X PBS (Ca<sup>2+</sup> and Mg<sup>2+</sup> free). Media used for cell culture can reduce the adhesion of the agarose to the CometSlides.

### **Adherent Cells**

Trypsinize cells with Trypsin-EDTA (0.25% Trypsin, 1 mM EDTA). First, wash the monolayer of cells with sterile PBS, pre-warmed to 37 °C. Add enough Trypsin-EDTA to coat entire monolayer. Incubate flask at 37 °C for 2 minutes or when cells easily become detached upon tapping of flask. Then add 10 ml of complete media (containing fetal bovine serum) to inactivate trypsin. Transfer cells to centrifuge tube. Perform cell count and then pellet cells. Wash once in ice cold 1X PBS (Ca<sup>2+</sup> and Mg<sup>2+</sup> free). Resuspend at 1 x 10<sup>5</sup> cells/ml in ice cold 1X PBS (Ca<sup>2+</sup> and Mg<sup>2+</sup> free).

### **Tissue Preparation**

Place a small piece of tissue into 1-2 ml of ice cold 1X PBS (Ca<sup>2+</sup> and Mg<sup>2+</sup> free), 20 mM EDTA. Using small dissecting scissors, mince the tissue into very small pieces and let stand for 5 minutes. Recover the cell suspension, avoiding transfer of debris. Count cells, pellet by centrifugation, and resuspend at 1 x 10<sup>5</sup> cells/ml in ice cold 1X PBS (Ca<sup>2+</sup> and Mg<sup>2+</sup> free). For blood rich organs (e.g., liver, spleen), chop tissue into large pieces (1-2 mm<sup>3</sup>), let settle for 5 minutes then aspirate and discard medium. Add 1-2 ml of ice cold 20 mM EDTA in 1X PBS (Ca<sup>2+</sup> and Mg<sup>2+</sup> free), mince the tissue into very small pieces and let stand for 5 minutes. Recover the cell suspension, avoiding transfer of debris. Count cells, pellet, and resuspend at 1 x 10<sup>5</sup> cells/ml in ice cold 1X PBS (Ca<sup>2+</sup> and Mg<sup>2+</sup> free).

### **Method for Cryopreservation of Cells Prior to FLARE™/CometAssay**

Certain cells, e.g. lymphocytes, may be successfully cryopreserved prior to performing CometAssay™ (Visvardis *et al.*). A pilot study should be performed to determine if cryopreservation is appropriate for the cells in use.

1. Centrifuge cells at 200 x g for 5 minutes.

2. Resuspend cell pellet at  $1 \times 10^7$  cells/ml in 10% (v/v) dimethylsulfoxide, 40% (v/v) medium, 50% (v/v) fetal calf serum.
3. Transfer aliquots of  $2 \times 10^6$  cells into freezing vials.
4. Freeze at  $-70\text{ }^\circ\text{C}$  with  $-1\text{ }^\circ\text{C}$  per minute freezing rate.
5. Recover cells by submerging in  $37\text{ }^\circ\text{C}$  water bath until the last trace of ice has melted.
6. Transfer to 15 ml of prechilled 40% (v/v) medium, 10% (w/v) dextrose, 50% (v/v) fetal calf serum.
7. Centrifuge at  $200 \times g$  for 10 minutes at  $4\text{ }^\circ\text{C}$ .
8. Resuspend in ice cold 1X PBS ( $\text{Ca}^{2+}$  and  $\text{Mg}^{2+}$  free) and proceed with FLARE™ Assay.

## VII. FLARE™ Assay Protocol

Modifications may be necessary for use of the **T4-Endo V FLARE™ Assay Kit** with other types of slides. The protocol utilizes alkali electrophoresis conditions, which detects single-stranded DNA breaks, double-stranded DNA breaks, and apurinic and apyrimidinic sites. Prior to performing the FLARE™ Assay, a cell viability assay should be performed to determine the dose of the test substance or treatment that gives at least 75% viability. False positives may occur when high doses of cytotoxic agents are used.

The FLARE™ assay requires approximately 3-4 hours to complete. Once the cells or tissues have been prepared, the procedure is not labor intensive. The Lysis Solution can be chilled and the LMAgarose melted while the cell and tissue samples are being prepared. The FLARE™ Assay involves the use of hazardous reagents including DMSO, strong alkali, and solutions containing detergents. Please exercise caution when handling any of these reagents. The use of a lab coat, eye protection, and gloves is recommended when preparing for and performing the FLARE™ Assay.

**Note: All steps are performed at room temperature unless otherwise specified. Work under dimmed or yellow light to prevent damage from UV.**

1. Prepare Lysis Solution (see Section V, *Reagent Preparation*, p.3) and chill at  $4\text{ }^\circ\text{C}$  or on ice for at least 20 minutes before use:
  - 40 ml Lysis Solution
  - 4 ml DMSO (Optional -use for samples containing heme)
2. Melt LMAgarose in a beaker of boiling water for 5 minutes, with the cap loosened. Place bottle in a  $37\text{ }^\circ\text{C}$  water bath for at least 20 minutes to cool. The temperature of the agarose is critical as the cells may undergo heat shock.
3. Refer to Section VI for sample preparation. Combine cells at  $1 \times 10^5$ /ml with molten LMAgarose (at  $37\text{ }^\circ\text{C}$ ) at a ratio of 1:10 (v/v) and immediately pipette 40  $\mu\text{l}$  onto FLARE™ Slide. Use side of pipette tip to spread agarose/cells over sample area.
  - 400  $\mu\text{l}$  Comet LMAgarose, molten and at  $37\text{ }^\circ\text{C}$  (Step 2).
  - 40  $\mu\text{l}$  cells in PBS ( $\text{Ca}^{2+}$  and  $\text{Mg}^{2+}$  free)

**Note:** If sample is not spreading evenly on the slide, warm the slide at 37 °C before application.

4. Place FLARE™ Slide flat at 4 °C in the dark (e.g. place in refrigerator) for 15 minutes or until a 0.5 mm clear ring appears at edge of sample area. Increasing gelling time to 30 minutes improves adherence of samples in high humidity environments.
5. Immerse slide in prechilled Lysis Solution and leave on ice or at 4 °C for 60 minutes. Lysis times can range from 30 minutes to overnight at 4 °C depending on the cell type.
6. Tap off excess buffer from slide and immerse in freshly prepared 1X FLARE™ Buffer 1 at room temperature to equilibrate the slide:
  - 6 ml 25X FLARE™ Buffer 1
  - 144 ml deionized water

Change the 1X FLARE™ Buffer 1 three times over a 30 minute period. Gently tap to remove excess liquid.

7. Add 75 µl of working T4-Endo V Enzyme Solution (see Section V, item 8) to each sample area. Remember to include a buffer-only control, e.g. For sample area 1 of FLARE™ Slide, apply buffer only; sample area 2, 1:500 dilution of T4-Endo V; and sample area 3, 1:1000 dilution of T4-Endo V. Alternatively, areas 2 and 3 can be combined as duplicate tests, and hydrophobic coverslips (cat# 4867-100) can be used to distribute the T4-Endo V test dilutions evenly. Carefully place slides horizontally in a humidity chamber and incubate at 37 °C for 30-60 minutes. Allow coverslips to detach by placing slides back into 1X FLARE™ Buffer 1 used in step 6.
8. Transfer FLARE™ Slide to a Coplin jar containing Alkali Solution at pH >13 (see Section V, item 9) and incubate for 20 minutes at room temperature in the dark. Change Alkali Solution once.
9. Transfer slide from Alkali Solution to a horizontal electrophoresis apparatus.
10. Place slides flat onto a gel tray and align equidistant from the electrodes.
11. Carefully pour the chilled Alkaline Solution until level just covers slides. We recommend adding the slides to the chamber with the running solution present, if possible. Set the voltage to about 1 Volt/cm. Perform electrophoresis for 20-40 minutes.

**Tips:** Since the Alkaline Electrophoresis Solution is a non-buffered system, **Temperature control is highly recommended.** In-house testing has shown great temperature fluctuations when conducting the alkaline electrophoresis at ambient temperature. To improve temperature control, the use of a large electrophoresis apparatus (25-30 cm between electrodes) is recommended along

with recirculation of the electrophoresis solution. Alternatively, performing the electrophoresis at cooler temperatures (e.g. 16 °C or 4 °C) will diminish background damage, ensure sample adherence at high pHs, and significantly improve reproducibility. Choose the method that is most convenient for your laboratory and always use the same conditions, power supply, and electrophoresis chamber for comparative analysis.

12. Gently tap off excess solution, immerse 2X into dH<sub>2</sub>O for 10 minutes each, and immerse in 70% ethanol for 5 minutes.
13. Dry slides at 45 °C for ~10 minutes, or 37 °C for ~30 minutes. Drying brings all the cells in a single plane to facilitate observation. Samples may be stored at room temperature with desiccant prior to scoring at this stage (see Appendix C).

**NOTE:** Trevigen offers the **CometAssay<sup>®</sup> Silver Staining Kit** designed for silver staining of comet tails (cat# 4254-200-K). Silver staining allows visualization by transmission light microscopy and permanently stains samples for archiving and long term storage. It is recommended that samples be dried before silver staining.

14. Place 100 µl of diluted SYBR<sup>®</sup> Green I (see Section V, item 10) onto each circle of dried agarose and place in refrigerator for 15-30 minutes. Allow slide to dry completely at room temperature in the dark.
15. View slide by epifluorescence microscopy. (SYBR<sup>®</sup> Green I's maximum excitation and emission are respectively 494 nm and 521nm. A fluorescein filter is adequate). If fading occurs, tap off excess SYBR<sup>®</sup> Green I and apply 50 µl of anti-fade solution (see Section V, item 11) onto each circle.

## VIII. Optimization of Assay Conditions

**For consistent results, the T4-Endo V FLARE™ Assay Kit requires optimization or consideration of the following parameters:**

### A) Temperature

During the process of DNA repair, abasic sites, nicks, and gaps in the DNA can be introduced that may generate comets in the FLARE™ assay. Repair is inhibited by cold temperatures, therefore, it is important to keep the cells and solutions used cold (4 °C or on ice) until cell lysis and deproteination are complete. Some repair has been reported even at 4 °C, therefore, cells should not be held at 4 °C for long periods of time before sample preparation. FLARE™ may be used to monitor the repair process in which case the cells would be incubated at physiological temperatures to allow repair, before analysis by FLARE™.

### B) Enzyme titration

T4-Endo V recognizes trans-syn thymine dimers and has an associated AP-lyase activity. Other FLARE Kits are available that may be more appropriate for the type of damage under investigation. We recommend that you titrate T4-Endo V to optimize the differences in tail moment between untreated and T4-Endo V-

E4/24/09v1

treated cells. Typical final dilutions of T4-Endo V used are 1:100, 1:500, and 1:1000. If necessary, up to 10 µl of undiluted enzyme can be applied in 100 µl of T4-Endo V FLARE Reaction Buffer (i.e. a final dilution of 1:10).

**C) Incubation times with T4-Endo V**

The optimum temperature for T4-Endo V is 37 °C. Vary the incubation time at 37 °C up to 1 hour with T4-Endo V so as to optimize the differences in tail moment between untreated and Endo III-treated cells.

**D) Health of your cells**

The comet assay is designed for assay of DNA in viable cells and your cells should be at least 95% viable as measured by Trypan Blue exclusion. The comet assay should not be used for detection of DNA damage under conditions of high cytotoxicity when there is massive secondary DNA damage. Note that extensive trypsinization may induce non-specific DNA damage and repair and, therefore, high background in Comet and FLARE™ Assays. When dealing with adherent cells, always use the most gentle trypsinization conditions for your cell type.

**IX. Controls**

Controls should be included in each experiment. Two samples of untreated cells incubated with T4-Endo V and T4-Endo V FLARE™ Reaction Buffer 1 should always be processed to control for endogenous levels of damage within cells and damage that may occur during sample preparation. Each FLARE™ Slide has three sample areas providing a convenient format for comparing samples with and without T4-Endo V treatment. If you require a sample that will be positive for comet tails, treat cells with freshly prepared 10-100 µM hydrogen peroxide or 5-25 µM KMnO<sub>4</sub> for 20 minutes at 4 °C. Hydrogen peroxide or KMnO<sub>4</sub> treatment will generate significant oxidative damage/DNA adducts in the majority of cells. Note that the dimensions and characteristics of the comet tail, as a consequence of hydrogen peroxide or KMnO<sub>4</sub> treatment, may be different from those induced by the damage under investigation.

**X. Data Analysis**

When excited (425--500 nm), DNA-bound SYBR® Green I emits green light. In healthy cells, the fluorescence is confined to the nucleoid: undamaged DNA is supercoiled and thus does not migrate very far from the nucleoid under the influence of an electric current. In cells that have accrued damage to the DNA, alkali treatment unwinds the DNA, releasing fragments that migrate from the cell when subjected to an electric field. The negatively charged DNA migrates toward the anode and the extrusion length reflects increasing relaxation of supercoiling, which is indicative of damage. When using alkaline electrophoresis conditions, the distribution of DNA between the tail and the head of the comet is used to evaluate the degree of DNA damage. The characteristics of the comet tail including length, width, and DNA content may also be useful in assessing qualitative differences in the type of DNA damage.

Qualitative Analysis

The comet tail can be scored according to DNA content (intensity). The control (untreated cells) should be used to determine the characteristics of data for a

healthy cell. Scoring can then be made according to nominal, medium, or high intensity tail DNA content. At least 75 cells should be scored per sample.

### Quantitative Analysis

There are several image analysis systems that are suitable for quantitation of CometAssay® data. The more sophisticated systems include the microscope, camera and computer analysis package. These systems can be set up to establish the length of DNA migration, image length, nuclear size, and calculate the tail moment. At least 75 randomly selected cells should be analyzed per sample.

NIH Image, free software for image analysis, is available at <http://rsb.info.nih.gov/nih-image>. A useful macro for calculating the tail moment from digital images is provided by Professor Herbert M. Geller, Ph.D. and can be obtained at <http://www2.umdj.edu/~geller/lab/comet.htm>.

## **XI. Troubleshooting Guide**

Problem	Cause	Action
In positive control (e.g. 100 µM hydrogen peroxide for 20 minutes on ice) no evidence of comet tail	No damage to DNA	Use freshly prepared reagents to induce damage
	Sample was not processed correctly	Ensure each step in protocol was performed correctly. Failure to lyse, denature in alkali, or to properly perform electrophoresis may generate poor results
Majority of cells in <b>untreated</b> control sample without T4-Endo V treatment have large comet tails.	Unwanted damage to cells occurred in culture or in sample preparations	Check morphology of cells to ensure healthy appearance  Handle cells or tissues gently to avoid physical damage
	Intracellular endonuclease activity	Keep cells on ice and prepare cell samples immediately before combination with molten LMAgarose
	LMAgarose too hot	Cool LMAgarose to 37 °C in water bath before adding cells
	Electrophoresis solution is too hot	Control temperature by recirculating electrophoresis solution or perform electrophoresis in a cold room
Majority of cells in <b>untreated</b> samples have large comet tails with obliterated nuclei after exposure to T4-Endo V	The concentration of T4-Endo V is too high	Titrate down the T4-Endo V to reduce or eliminate the comet in the untreated cells. Altering the enzyme concentration and incubation times are necessary to <b>maximize</b> the difference in comet tail size between treated and untreated cells
	Incubation time with the DNA repair enzyme is too long	Reduce incubation times
	Endogenous DNA damage due to handling conditions	Refer to first troubleshooting section on previous page

Problem	Cause	Action
Majority of cells in <b>untreated</b> control sample without T4-Endo V treatment have small to medium comet tails	Endogenous oxidative damage or endonuclease activity is damaging DNA during sample preparation	<p>Ensure lysis solution was thoroughly chilled before use</p> <p>Add DMSO to any cell sample that may contain heme groups</p> <p>Ensure PBS used is calcium and magnesium free</p> <p>Work under dimmed light conditions or under yellow light</p>
Cells in LMAgarose did not remain attached to FLARE™ Slide.	<p>Electrophoresis solution is too hot</p> <p>Cells were not washed to remove medium before combining with LMAgarose.</p> <p>Agarose percentage was too low.</p> <p>LMAgarose not fully set before samples processed.</p> <p>LMAgarose unevenly set on slide.</p>	<p>Control temperature by recirculation of electrophoresis solution, or conduct electrophoresis in a cold room</p> <p>The pH of medium and carry over of serum proteins etc. can reduce the adhesion of the agarose. Resuspend cells in 1X PBS.</p> <p>Do not increase ratio of cells to molten agarose by more than 1 to 10 e.g. add 50 µl of cell suspension to 500 µl of molten LMAgarose.</p> <p>Ensure 0.5 mm dried ring due to agarose disc retraction is seen at edge of sample area. Extend gelling time to 30 minutes at 4 °C.</p> <p>Spread the agarose with the side of a pipette tip to ensure uniformity of agarose disc and better adherence</p>
Comet tails present but not significant in positive control	<p>Insufficient denaturation in Alkali Solution</p> <p>Insufficient electrophoresis time</p> <p>Buffer level during electrophoresis too high</p>	<p>Increase time in Alkali Solution up to one hour</p> <p>Increase time of electrophoresis up to 40 minutes. Maintain voltage at 1 volt/cm</p> <p>Remove some buffer from electrophoresis chamber. If too much alkali buffer is present, migration will not occur.</p>

## XII. References

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### XIII. Related Products Available From Trevigen

Contact Trevigen for details of our unique product line for studying DNA damage and repair. All of Trevigen's kits include highly qualified enzymes, substrates, buffers, full instructions for use, and a synopsis specific for your kit.

#### FLARE™ Assay Kits:

Catalog #	Description	Damage Recognized	Size
4045-100-FK 4045-100-FM	Endo III	Thymine glycol, 5,6-dihydrothymidine urea, 5-hydroxy-6-dihydrothymine, alloxan, etc.	75 samples 100 samples
4065-100-FK 4065-100-FM	cv-PDG	Cis-syn and trans-syn isomers of cyclobutane pyrimidine dimers	75 samples 100 samples
4025-100-FK 4025-100-FM	UNGase	Uracil	75 samples 100 samples
4130-100-FK 4130-100-FM	hOGG1 Kit	8-oxoguanine, DNA containing formamidopyrimidine moieties	75 samples 100 samples
4055-100-FK 4055-100-FM	T4-PDG Kit	Cis-syn isomers of cyclobutane pyrimidine dimers	75 samples 100 samples
4100-100-FK 4100-100-FM	UVDE Kit	Cyclobutane pyrimidine dimers, (6-4) photoproducts	75 samples 100 samples
4040-100-FK 4040-100-FM	Fpg Kit	8-oxoguanine, DNA containing formamidopyrimidine moieties	75 samples 100 samples

## CometAssay® Kits:

Catalog #	Description	Size
4250-050-K	CometAssay®	50 samples
4251-050-K	CometAssay® Silver Kit	50 samples
4254-200-K	CometAssay® Silver Staining Kit	200 samples
4252-040-K	CometAssay® Higher Throughput Kit	40 samples
4253-096-K	CometAssay® Kit 96 Wells	96 samples
4250-050-ES	CometAssay® Electrophoresis System	1 system
4250-050-ESK	CometAssay® Electrophoresis Starter Kit	1 kit

## Control Cells:

Catalog #	Description	Size
4256-010-CC	CometAssay® Control Cells	10 assays

## PARP Assay Kits:

Catalog #	Description	Size
4685-096-K	HT Chemiluminescent PARP Apoptosis Assay	96 tests
4684-096-K	HT Colorimetric PARP Apoptosis Assay	96 tests
4677-096-K	HT Universal Colorimetric PARP Assay w/ Histone Coated Strip Wells	96 samples
4676-096-K	Universal Chemiluminescent PARP Assay w/Histone Coated Strip Wells	96 samples
4668-100-1	Recombinant Human PARP (High Specific Activity)	1000 Units
4510-096-K	PARP in vivo Pharmacodynamic Assay	96 tests

## DNA Damage Antibodies:

Catalog #	Description	Size
4410-PC-100	Fen-1	100 µl
4411-PC-100	γ-H2AX	100 µl
4350-MC-100	UVssDNA	100 µg
4431-MC-100	XPF	100 µg
4421-MC-100	XRCC1	100 µg
4354-MC-50	anti-8-oxo-dG monoclonal	50 µl

## Accessories:

Catalog #	Description	Size
4867-100	Hydrophobic Coverslips 22 x 40 mm	100 each
4250-050-03	CometSlide™ (2 well)	25 slides
4252-200-01	CometAssay® HT Slide (20 well)	10 slides
4253-960-03	96 Well CometSlide™	10 slides
3950-300-02	FLARE™ Slides	100 slides
4040-100-FM	Fpg FLARE™ Module	>100 samples
4130-100-FM	hOGG1 FLARE™ Module	>100 samples
4045-100-FM	Endonuclease III FLARE™ Module	>100 samples
4065-100-FM	cv-PDG FLARE™ Module	>100 samples
4100-050-FM	UVDE FLARE™ Module	>100 samples
3950-075-SP	FLARE™ Sample Prep	>100 samples

## XIV. Appendices

### Appendix A

#### SYBR® Green I nucleic acid gel stain licensing terms:

This product is sold under license from Molecular Probes, Inc. under US Patents Nos. 5,436,134 and 5,658,751 for use in a comet assay for internal research and development only, where research and development use expressly excludes the use of this product for providing medical, diagnostic or any other testing analysis or screening services or providing clinical information or clinical analysis, in return for compensation on a per-test basis, and research and development use expressly excludes incorporation of this product into another product for commercialization even if such other product would be commercialized for research and/or development use.

### Appendix B

#### Reagents and Buffer Composition:

##### T4-Endo V (cat# 4040-100-01)

Please contact Trevigen for lot specific data.

T4-Endo V is a DNA glycosylase with an associated AP lyase activity that is specific for *trans-syn* isomers of cyclobutane pyrimidine dimers and AP sites.

##### Comet LMAgarose (cat# 4250-050-02)

1% low melting point agarose  
1X PBS

##### 25X FLARE™ Buffer 1 (cat# 3950-040-01)

250 mM HEPES-KOH, pH 7.4  
2.5 M KCl  
250 mM EDTA

##### REC™ Dilution Buffer (cat# 3950-010-03)

10 mM HEPES-KOH, pH 7.4  
100 mM KCl  
0.1 mg/ml BSA  
50% glycerol

##### 100X BSA Additive (cat# 3950-100-04)

Proprietary stabilizer reagent

##### Lysis Solution (cat# 4250-050-01)

2.5 M sodium chloride  
100 mM EDTA, pH 10  
10 mM Tris base  
1% sodium lauryl sarcosinate  
1% Triton X-100

### Appendix C

#### Storing FLARE™ Slides/CometSlides™:

Slides may be stored for several months in a low humidity atmosphere prior to staining with SYBR® Green I by fixing the samples in 70% ethanol and drying:

1. After electrophoresis, immerse slides 2X in dH<sub>2</sub>O for 10 minutes each and in 70% ethanol for 5 minutes.
2. Drain excess alcohol and lay slide flat to dry at 45 °C for ~10 minutes.
3. Store at room temperature with desiccant.

4. For scoring, cover sample areas with diluted SYBR<sup>®</sup> Green I and proceed with viewing.

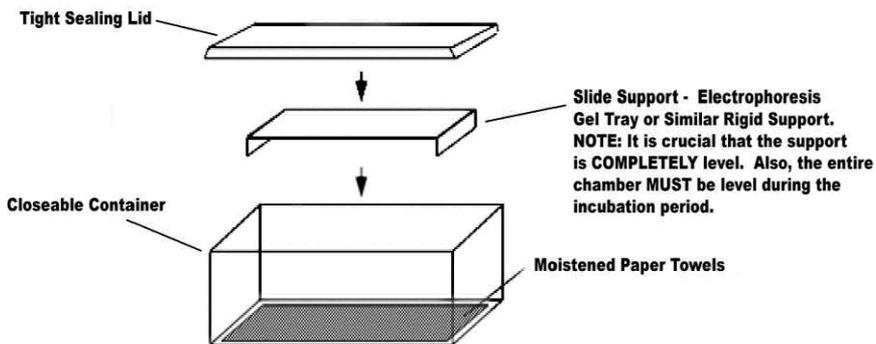
## Appendix D

### Silver Staining of FLARE<sup>™</sup> Slides/CometSlides<sup>™</sup>:

Silver staining offers the opportunity to visualize comets on any transmission light microscope and allows for long term storage. Trevigen recommends the use of our Silver Staining Kit, cat# 4254-100-K.

## Appendix E. Humidity Chamber

To prevent evaporation it is recommended that incubations at 37 °C are carried out in a humidity chamber. A humidity chamber can be made using a plastic box with a tight fitting lid and two glass rods or other support. Place paper towel on the bottom of the box and wet thoroughly with water. Lay the glass rods parallel to each other and less than one slide length apart on the wet tissue. Position the slides on the glass rods and place the plastic box, with lid, in a 37 °C incubator. Ensure that the slides are horizontal.



**The product accompanying this document is intended for research use only and is not intended for diagnostic purposes or for use in humans.**



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